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METEOROLOGICAL OFFICE

CLIMATOLOGICAL SERVICES (M.O.3)

CLIMATOLOGICAL MEMORANDA, No. 29

RAIN AND/OR LOW TEMPERATURE AS FACTORS INTERRUPTING EXTERNAL BUILDING WORK IN THE MANCHESTER AREA

by P.R. BROWN, M.Sc.

INTRODUCTION

This is an investigation of the same type as that described for the London area in Climatological Memoranda, No. 27.

Weather factors most commonly responsible for interrupting external building work in the British Isles, are probably rain and/or coldness. Building contractors sometimes wish to know (e.g. when estimating the completion date of a contract) the monthly percentage frequencies of time likely to be 'lost' due to rainfall or low air temperature, or to these factors in combination.

It is probable that the critical rate (or intensity) of precipitation which would be likely to cause external work to be interrupted, varies with a number of other meteorological factors including the direction and strength of wind, temperature (not restricted to a suggested threshold of 34°F. as used in this particular analysis), state of ground (e.g. flooded, snow-covered, frozen), thick fog, etc., and also with a number of non-meteorological factors. However, it was considered that helpful results would be obtained by finding the percentage of time during the day that the rate of precipitation was 0.5 mm. per hour or more.

The results of this investigation are considered to be applicable without appreciable error to the Manchester area as a whole, although the data used was for Manchester Airport.

Although this is a continuation of Memoranda No. 27 it may be used separately; therefore the sections PRECIPITATION, TEMPERATURE and COMMENT of that memoranda will be repeated.

DATA

Hourly observations (on punched cards) for Manchester Airport for 12-hour period 06-18 G.M.T. daily during the ten year period 1949 - 1958 were used. They excluded, however, observations for the period 17th December, 1952 to the 31st January, 1953 inclusive as there were no hourly records of rainfall during this period owing to an instrumental failure.

PRECIPITATION

Intensity or rate of fall is the determining factor in classifying precipitation (rain, drizzle, snow or hail) as slight, moderate or heavy, not the total fall over a period of an hour or more, and the rate of 0.5 mm. per hour corresponds to the upper limit of slight rain. This scale of intensity needs to be increased when applied to showers, for a threshold rate of 0.5 mm./hr. would probably cause practically all showers to be included in the frequencies of

G.45323/AW/5/61/50

"appreciable" precipitation in this investigation. Special observational techniques are used to measure rainfall when all the precipitation has occurred as snow; as a rough approximation, a rate of rainfall of 0.5 mm./hr. would correspond to an accumulation of snow at a rate of 6.0 mm./hr., and it seems unlikely that external building operations would have to cease because of slight snow falling for a relatively short period at this rate (perhaps with the air temperature being 34°F. or just above).

In the absence of any experimental evidence, and after discussion with the Building Research Station, D.S.I.R., it was decided that the lower limit of precipitation contributing to time lost in the building industry through inclement weather should be set at this rate of 0.5 mm./hr. Since this figure was somewhat arbitrarily fixed, no advantage was to be gained by attempting to refine the procedure or to apply weighting factors to the results in order to allow for the unnecessary inclusion of slight showers or occasions of slight snow; it seems reasonable to suppose that, as an average figure for each month over the whole year, and bearing in mind the complexity of the basic problem, the rate of 0.5 mm./hr. is not likely to be very wrong.

TEMPERATURE

Air temperatures are punched on the cards in whole degrees Fahrenheit, and that part of the analysis which deals with temperatures less than 34°F. actually uses a threshold temperature of 33.6°F. i.e. 33.6°F. would be "rounded-up" and punched as 34 whilst 33.5°F. would be punched as 33. The temperature criterion of 34°F. (actually 33.6°F.) would seem to be quite reasonable, but it must be remembered that there will be occasions when the ground is frozen for several hours with the air temperature 33.6°F. or higher; perhaps the number of these occasions will be approximately counter-balanced by the number of occasions when external work is able to proceed even though the air temperature is below 33.6°F.

COMMENT

It seems likely that the criteria of rain and temperature conditions liable to interrupt external building work will be more or less the same over the British Isles, although the critical rate of rainfall may show a seasonal variation, e.g. perhaps a rate of 0.7 mm./hr. may be generally tolerable in the summer whereas a rate of 0.4 mm./hr. might often induce men to take shelter in the winter.

As previously stated, there are other meteorological factors, of which wind direction and speed are though to be most important, and many non-meteorological factors which could not be considered but which were referred to in a letter received from a firm of building contractors:-

> "... we would expect to find variations between the persistency of different gangs reflecting the different types of work being done, the extent to which protective clothing had been issued, the tenacity of the foreman, and even on whether the men were on bonus or not".

Polythene shelters to cover the building site, or part of the site, obviate loss of working time due to inclement weather, and this note may help contractors to decide for particular jobs whether it is an economic proposition to use them.

The effect of weather on building materials is a separate problem.

TABULATION OF RESULTS

Table 1 gives the number of hours with air temperature less than 34°F whether or not precipitation was occurring, the total number of hours (from 6.00 a.m.-6.00 p.m. GMT daily) each month in the ten-year period, and the percentage frequency of hours with temperature less than 34°F. (irrespective of precipitation).

Table 2 gives the total duration, in hours and tenths of precipitation at a rate of 0.5 mm./hr. or more, the percentage duration, and the total number of occasions.

Table 3 gives the total duration of precipitation at a rate of 0.5 mm./hr. or more with temperature simultaneously less than 34°F.

Tables 2 and 3 also give the average duration for each month with precipitation and for each month with precipitation and low temperature, respectively.

CRITICISM OF RESULTS

In Tables 2 and 3 it should be stressed that the average durations have been computed from the hourly duration of rainfall at a rate of 0.5 mm./hr. or more in hourly observations on punched cards: the number of occasions is the number of cards which have rainfall of this rate punched on them. Hence if a period of rain of rate 0.5 mm./hr. or more occurs between, for example, 8.30 a.m. and 9.30 a.m. this will be reported on two cards as 30 minutes duration on each. Thus the 'average' duration is computed as 30 minutes whereas it should be 60 minutes. Thus it will be seen that the average durations quoted will be somewhat low. The average durations have been included in this memoranda, however, to make the results comparable with those given in Climatological Memoranda No. 27 for the London area. It should be noted that the above criticism does not apply to total duration or to percentage duration.

The number of occasions in Table 3 is too small in April and November to allow a significant average duration to be computed and for those computed for other months the number of occasions is too small to make them reliable.

DISCUSSION OF RESULTS

This investigation includes all days, ignoring week-ends or holidays and it should be remembered that all the results refer to the period 6.00 a.m. to 6.00 p.m. G.M.T.

Let us consider the three simplified tabulations:-

Table (a) Temperature below 34°F., no precipitation at or above the rate of 0.5 mm./hr.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
Percentage Hours	19.0	18.1	7.1	0.5	-	-	-	-	-	0.9	4.4	11.0

Table (b) Appreciable precipitation (i.e. rate of 0.5 mm./hr. or more) with no restriction on temperature.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec
Percentage Hours	5.9	5.8	5.2	4.2	4.4	4.8	5.2	6.7	5.4	5.6	6.3	7.2

G.45323/AW/5/61/50

Table (c) Temperature below 34°F and/or precipitation at rate of 0.5 mm./hr. or more.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
Percentage Hours	24.9	23.9	12.3	4.7	4.4	4.8	5.2	6.7	5.4	6.5	10.7	18.2

The above results are shown in the form of a histogram in Fig. 1.

The period January 1949 - December 1948 includes the unusually cold months January, February and March, 1955 but excludes the winter of 1946 - 47, which was remarkable for an exceptionally long unbroken period of bitterly cold weather (for details see M.O.3 Climatological Memoranda No. 4 "A Comparison of the Winters of 1946-47 and 1954-55", by R.E. Booth).

The 30-year average 1921-50 of the mean temperature over England and Wales for the winter months December, January and February is 40.9°F. while the 10-year average 1949-58 is 40.7°F., so that the ten winters considered in this investigation may be regarded as representative of long-term average temperature conditions. The annual rainfall over England and Wales, expressed as a percentage of average for the 35-year period 1916-50, for each year from 1949 to 1958 inclusive, is:-

1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
85	110	120	97	82	117	85	94	97	114

and these values give an average over the ten years of 100%, so that on the basis of rainfall the period is representative, so far as England and Wales are concerned, of the longer 35-year standard period.

There is no reason to suspect that temperature and rainfall data at Manchester Airport for the period 1949-1958 inclusive are not reasonably representative of long-term average conditions in the Manchester area.

The above results in Table (c) show that the time 'lost' through low temperature and/or rainfall is between 4 and 7% in the Manchester area between April and October inclusive and is over 18% from December to February inclusive. Table (b) shows that there is no great variation in the time 'lost' through rainfall (with no restriction on temperature) in the Manchester area throughout the year. However, the months April to June inclusive are the best for external building purposes from both the rainfall aspect as well as from the aspect of rainfall and low temperature (see Table (c)).

The right hand column of Table 2 gives the average duration of rain at the rate of 0.5 mm./hr. or more, the average for the year being rather under 32 minutes. A criticism of these results was given in the preceding section.

It may be computed from Table 3 that the percentage of hours 'lost' when the temperature is less than 34°F and also precipitation is occurring at a rate of 0.5 mm./hr. or more is given by (expressing the number of occasions as a percentage of the total hours):-

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
Percentage Hours	1.2	1.2	0.4	0.0	-	-	-	-	-	-	0.0	0.8

G.45323/AW/5/61/50

COMPARISON WITH DATA FOR LONDON AREA

The results obtained in this investigation for the Manchester area will now be compared with those obtained for the London area in Climatological Memoranda No. 27. For convenience we will repeat Tables (a), (b) and (c) for the two areas:

Table (a) Temperature below 34°F, no precipitation at or above the rate of 0.5 mm./hr.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
London percentage hours	15.1	17.1	5.9	0.2	-	-	-	-	-	1.4	3.7	10.2
Manchester percentage hours	19.0	18.1	7.1	0.5	-	-	-	-	-	0.9	4.4	11.0

Table (b) Appreciable precipitation (i.e. rate 0.5 mm./hr. or more) with no restriction on temperature.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
London percentage hours	3.8	5.9	3.2	2.7	3.2	2.8	3.4	3.5	3.3	4.2	4.9	3.9
Manchester percentage hours	5.9	5.8	5.2	4.2	4.4	4.8	5.2	6.7	5.4	5.6	6.3	7.2

Table (c) Temperature below 34°F. and/or precipitation at rate of 0.5 mm./hr. or more.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
London percentage hours	18.9	23.0	9.1	2.9	3.2	2.8	3.4	3.5	3.3	5.6	8.6	14.1
Manchester percentage hours	24.9	23.9	12.3	4.7	4.4	4.8	5.2	6.7	5.4	6.5	10.7	18.2

It will be seen from the above three tables that the percentage hours 'lost' both for rainfall of 0.5 mm./hr. or more and temperature less than 34°F are greater for the Manchester area than for the London area for most months. There are however some exceptions, e.g. in Table (a) the percentage hours 'lost' when temperature is less than 34°F with no precipitation at or above the rate 0.5 mm./hr. for October is 1.4 for London and 0.9 for Manchester.

Considering the Table (b) for August it can be seen that the percentage hours 'lost' due to rainfall are 6.7 for Manchester against only 3.5 for London. For all months other than February the percentage hours 'lost' for rainfall are appreciably greater for Manchester than for London.

The results can be summarised by saying that generally there should be appreciably less hours 'lost' on external building on account of low temperature and rainfall of rate 0.5 mm./hr. or more in the London area than in the Manchester area.

G.45323/AW/5/61/50

TABLE 1. Frequency of hours with air temperature less than 34°F irrespective of precipitation.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
Total hours	3348*	3384	3720	3600	3720	3600	3720	3720	3600	3720	3600	3540*
No. of hours with temp. less than 34°F	676	652	278	20	-	-	-	-	-	35	159	419
Percentage hours	20.2	19.3	7.5	0.6	-	-	-	-	-	0.9	4.4	11.8

TABLE 2. Duration of precipitation at rate 0.5 mm./hr. or more irrespective of temperature.

Month	Total hours 06-18 G.M.T.	Rainfall duration at rate 0.5 mm./hr. or more in hours and tenths	Percentage duration	No. of Occasions	Average duration of rain at rate 0.5 mm./hr. or more per occasion in minutes
Jan.	3348*	196.2	5.9	353	33
Feb.	3384	197.9	5.8	355	33
Mar.	3720	191.8	5.2	312	37
Apr.	3600	150.3	4.2	293	31
May	3720	163.1	4.4	352	28
June	3600	172.4	4.8	350	30
July	3720	192.6	5.2	388	30
Aug.	3720	250.4	6.7	478	31
Sept	3600	193.9	5.4	410	28
Oct.	3720	208.1	5.6	388	32
Nov.	3600	227.4	6.3	407	34
Dec.	3540*	256.4	7.2	470	33

TABLE 3. Duration of precipitation at rate 0.5 mm./hr. or more with temperature less than 34°F.

Month	Total hours 06-18 G.M.T.	Rainfall duration at rate 0.5 mm./hr. or more and temperature below 34°F	Number of Occasions	Average duration at rate 0.5 mm./hr. or more per occasion in minutes
Jan.	3348*	27.1	40	41
Feb.	3384	27.4	41	40
Mar.	3720	10.0	15	40
Apr.	3600	1.0	1	-
Nov.	3600	.2	1	-
Dec.	3540*	23.0	30	46

* See paragraph DATA for reason that the total number of hours is less than maximum possible for December and January.

G.45323/AW/5/61/50

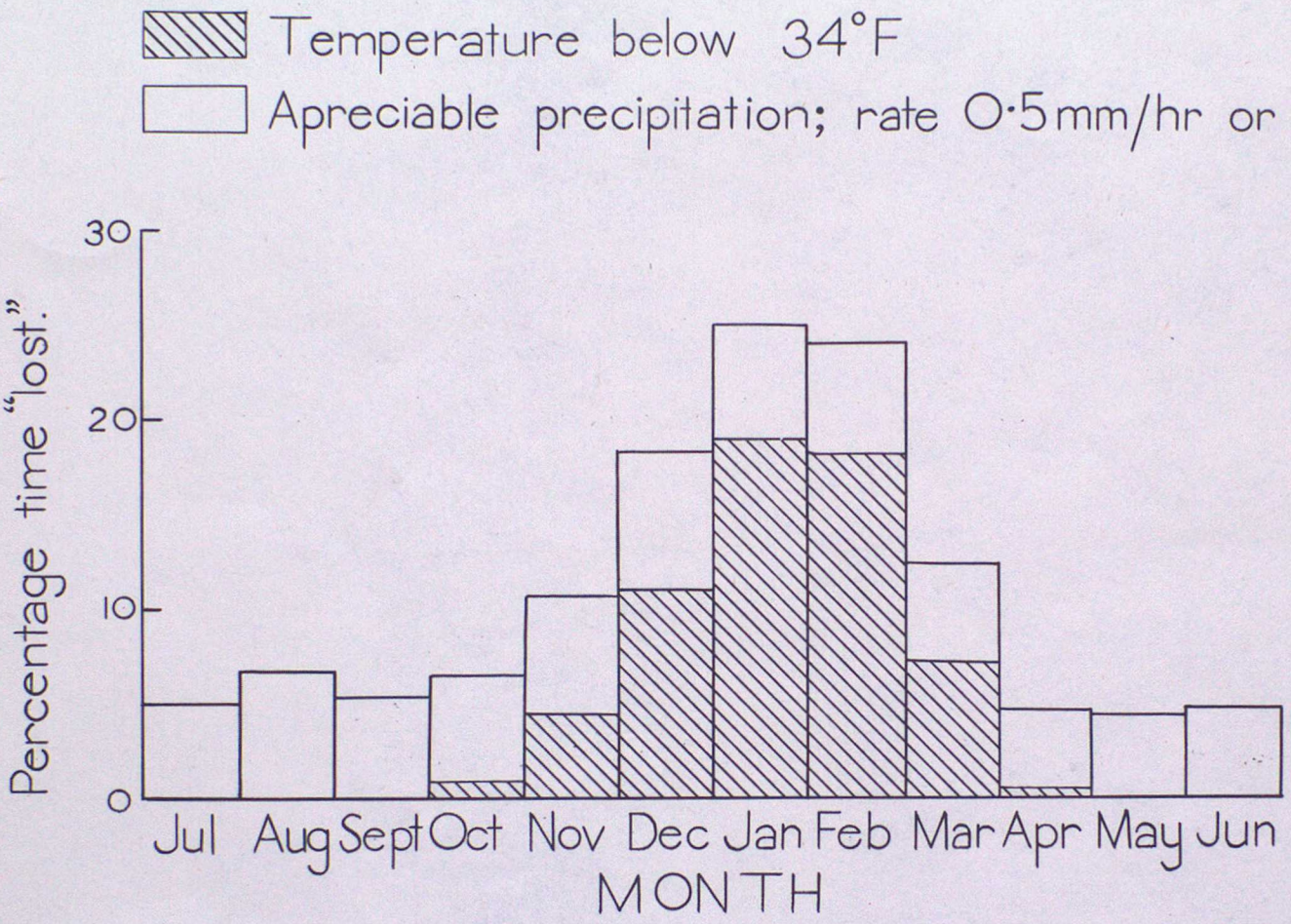

Fig 1. Percentage time "lost" due to rain and/or low temperature interrupting external building work in the Manchester area.